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Yu et al.

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(54) **MOTORIZED WINDOW SHADE AND METHOD OF OPERATING THE SAME**

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(51) **Int. Cl.**

E06B 9/38	(2006.01)
E06B 9/262	(2006.01)
E06B 9/68	(2006.01)

(52) **U.S. Cl.**

CPC . ***E06B 9/38*** (2013.01); ***E06B 9/262*** (2013.01); ***E06B 9/68*** (2013.01); *E06B 2009/2625* (2013.01); *E06B 2009/6845* (2013.01); *E06B 2009/6872* (2013.01)

(58) **Field of Classification Search**

CPC E06B 9/68; E06B 9/70; E06B 9/72; E06B 9/32; E06B 9/322; E06B 2009/6845; E06B 2009/689; E06B 9/38; E06B 9/262; E06B 2009/2625

See application file for complete search history.

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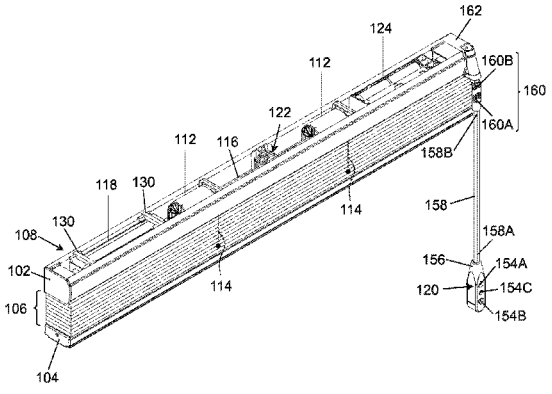
(57) **ABSTRACT**

A motorized window shade includes a covering structure arranged between a fixed and a movable rail, an electric motor operable to drive displacement of the movable rail relative to the fixed rail, a control interface operable to control operation of the electric motor, and a motor controller respectively connected with the electric motor and the control interface. The control interface includes a first, a second and a third button, the first and second buttons being respectively operable to cause displacement of the movable rail in two opposite directions. The motor controller can record a current position of the movable rail as a limit position of the movable rail in response to a pressure concurrently applied on the third button and one of the first and second buttons. In some embodiments, methods of operating the motorized window shade are also described.

23 Claims, 12 Drawing Sheets



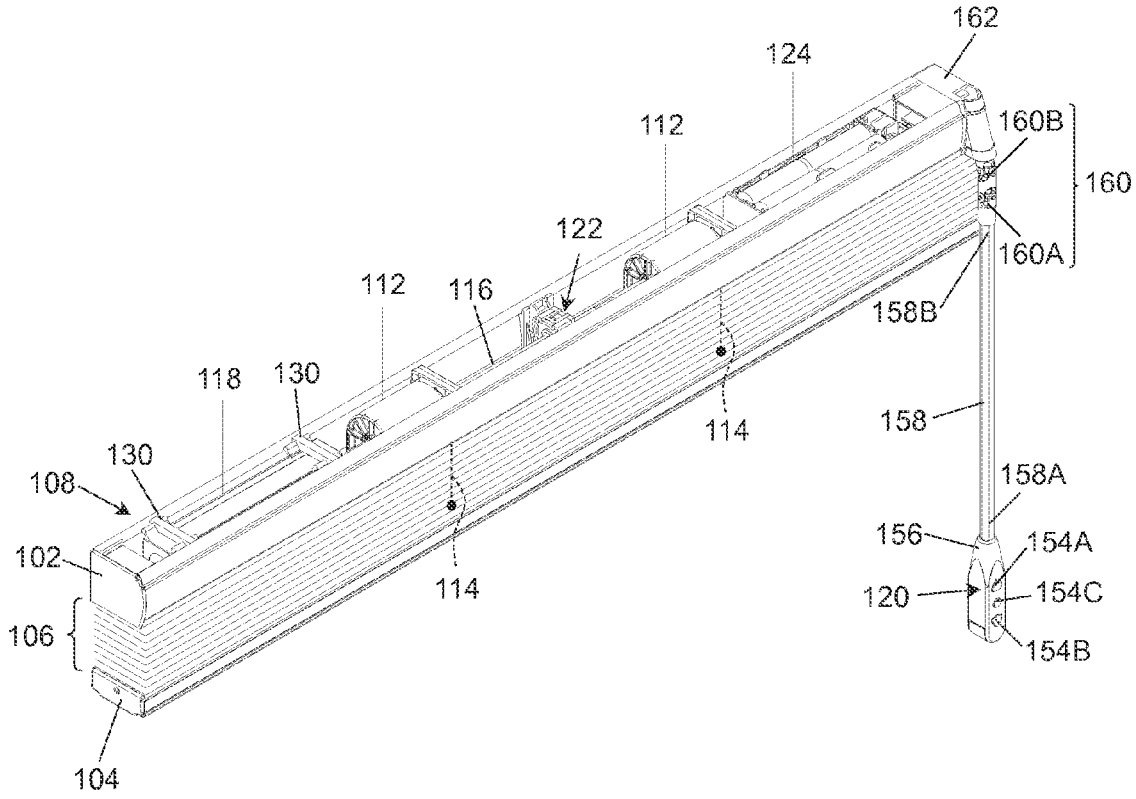

100
162
124
112
160B
160
122
160A
112
116
158B
118
130
114
158
130
158A
108
156
154A
102
114
120
154C
106
154B
104

FIG. 1

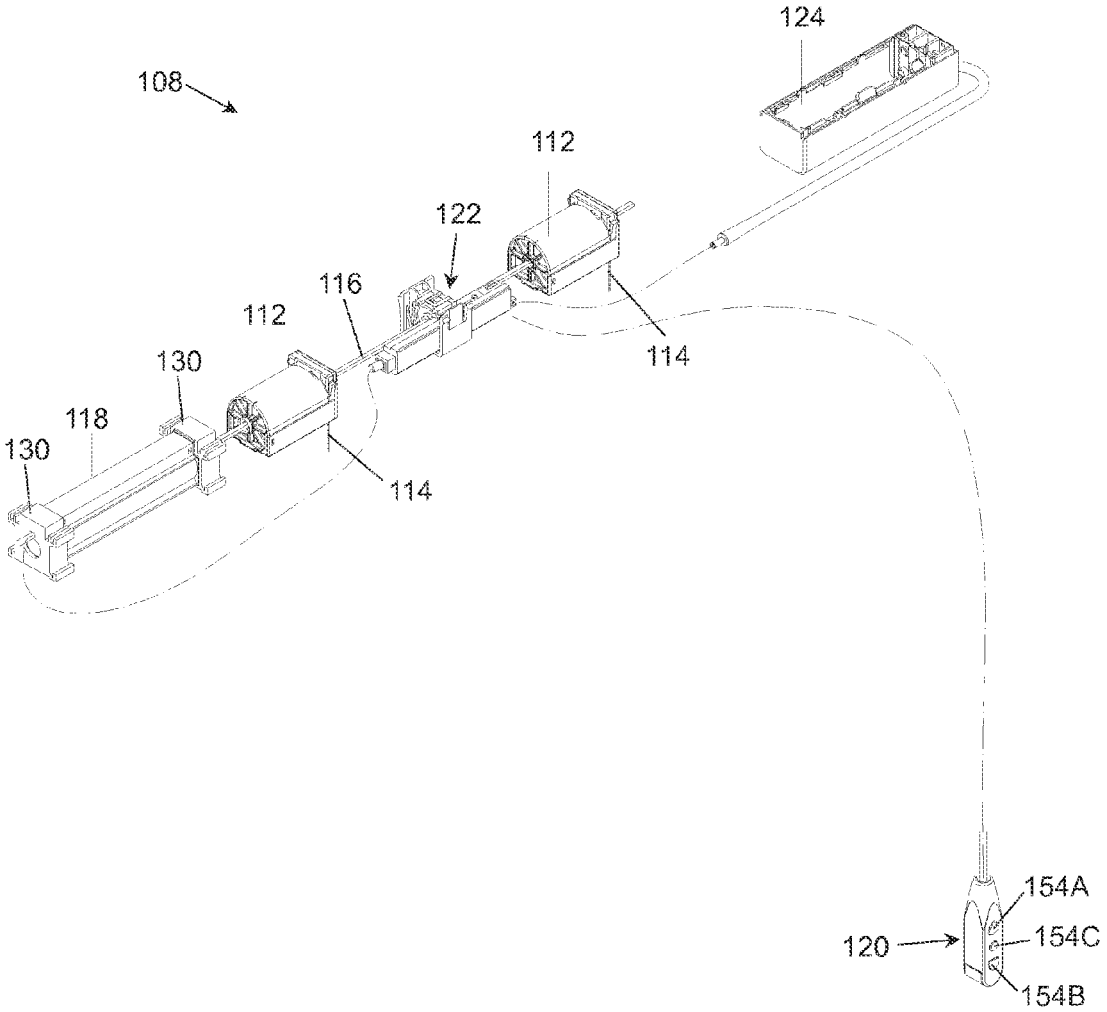


FIG. 2

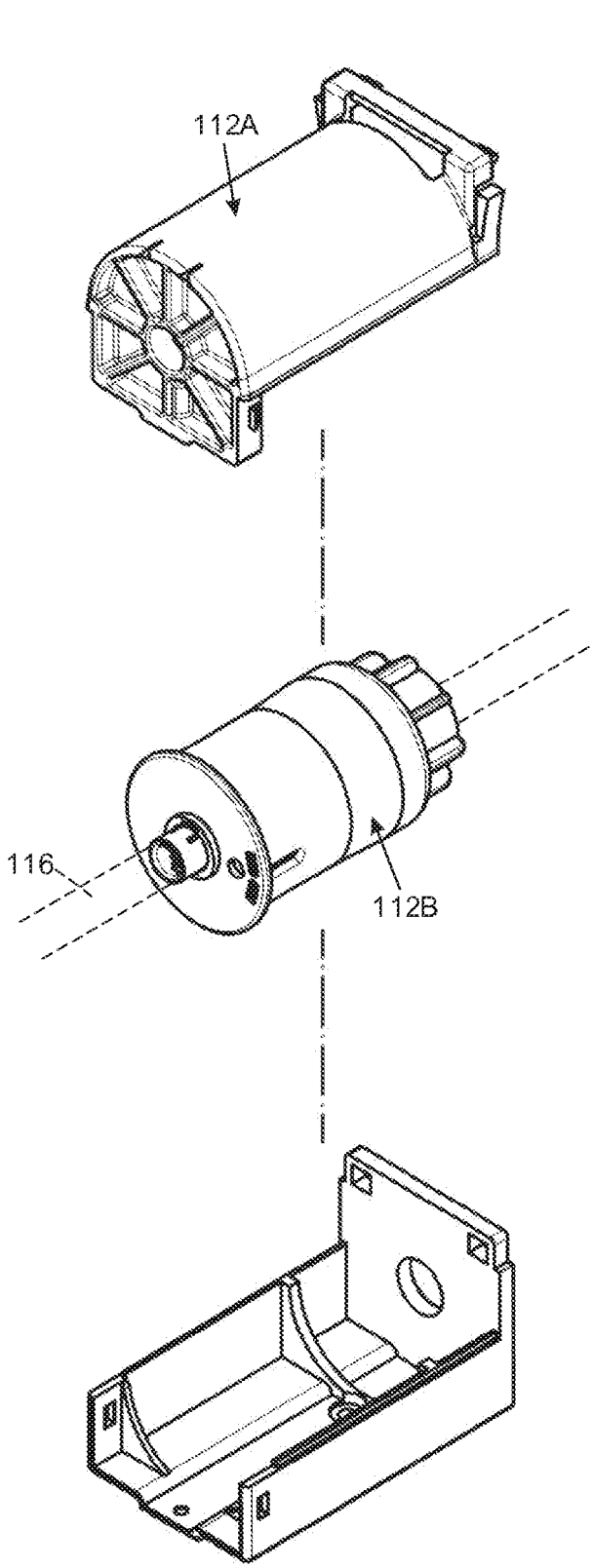


FIG. 3

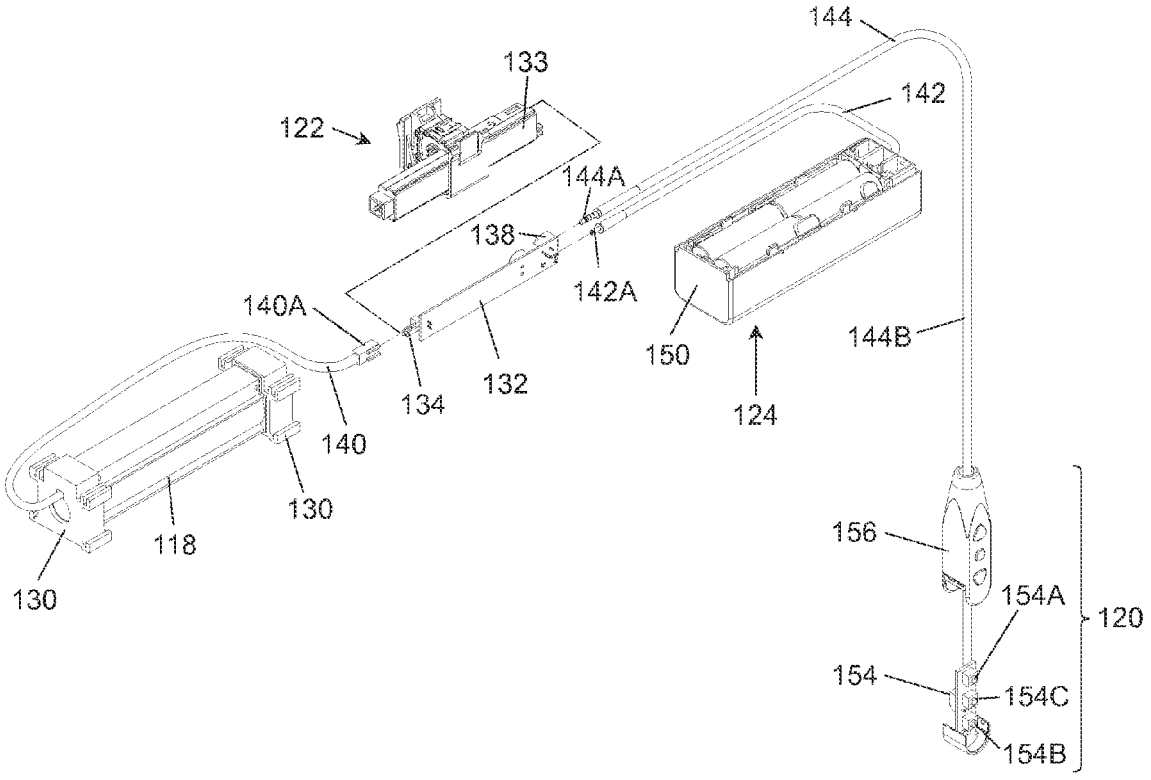

144
133
142
122
144A
138
142A
140A
150
144B
132
134
124
140
130
118
130
156
154A
120
154
154C
154B

FIG. 4

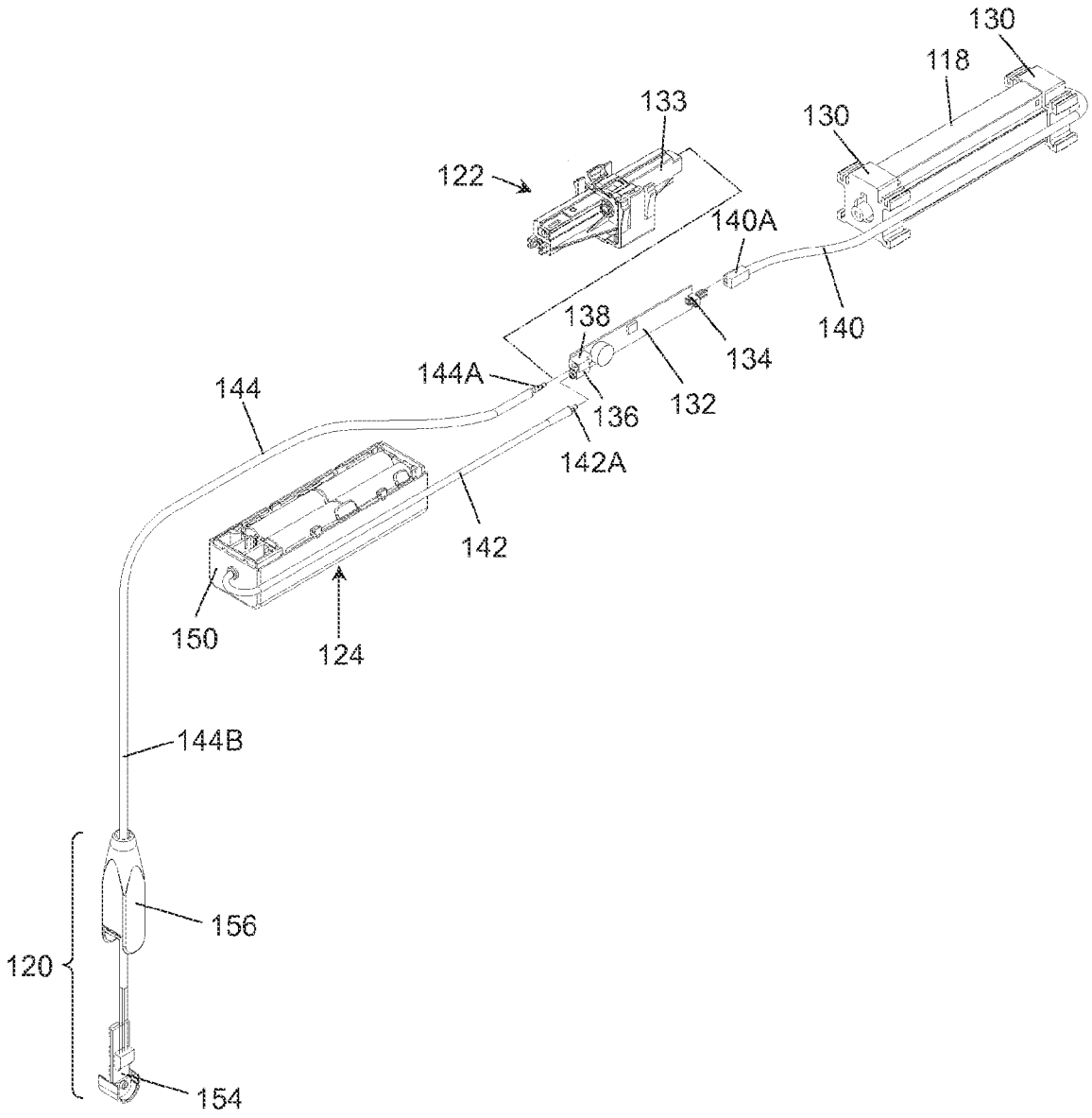

130
118
133
130
122
140A
138
140
134
144A
144
136
132
142A
142
150
124
144B
156
120
154

FIG. 5

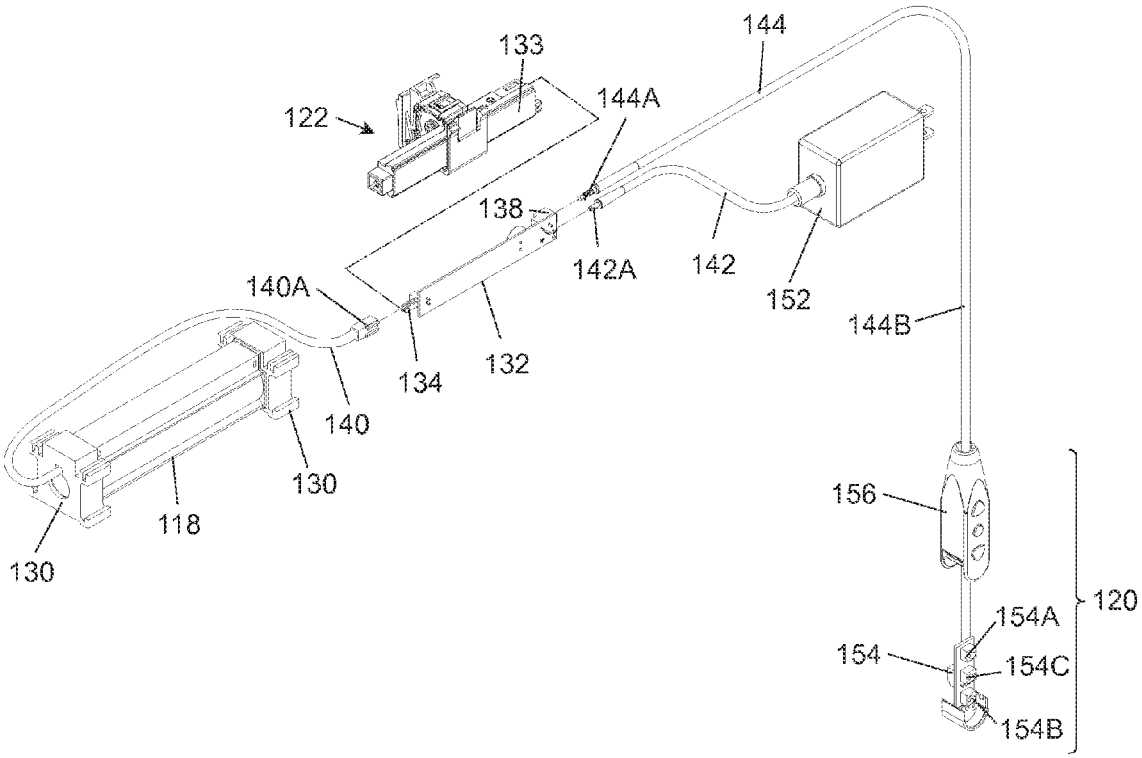

144
133
122
144A
138
142A
142
152
140A
144B
132
134
140
130
118
130
156
120
154A
154
154C
154B

FIG. 6

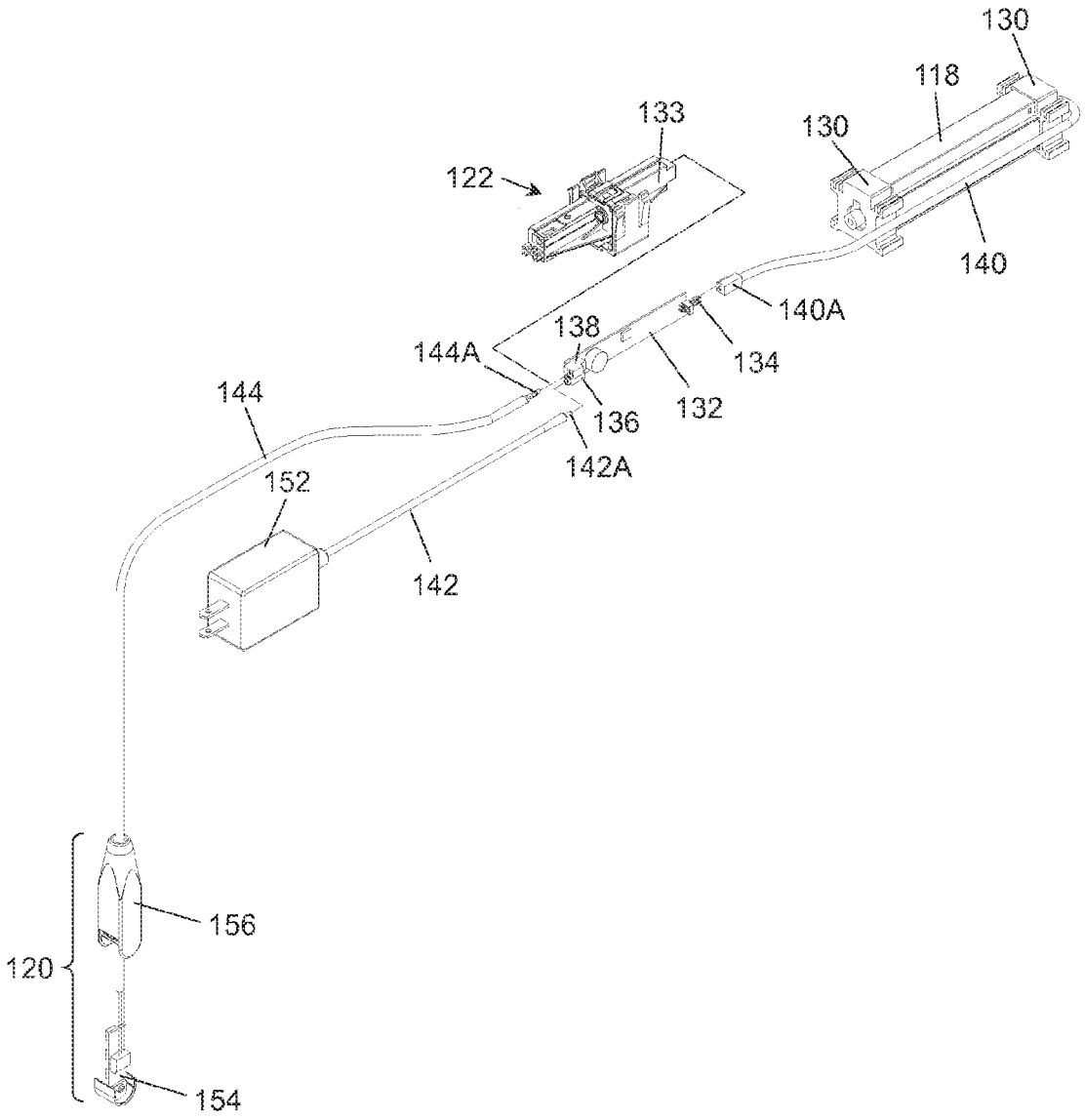

130
118
133
130
122
140
140A
138
144A
134
144
136
132
142A
152
142
156
120
154

FIG. 7

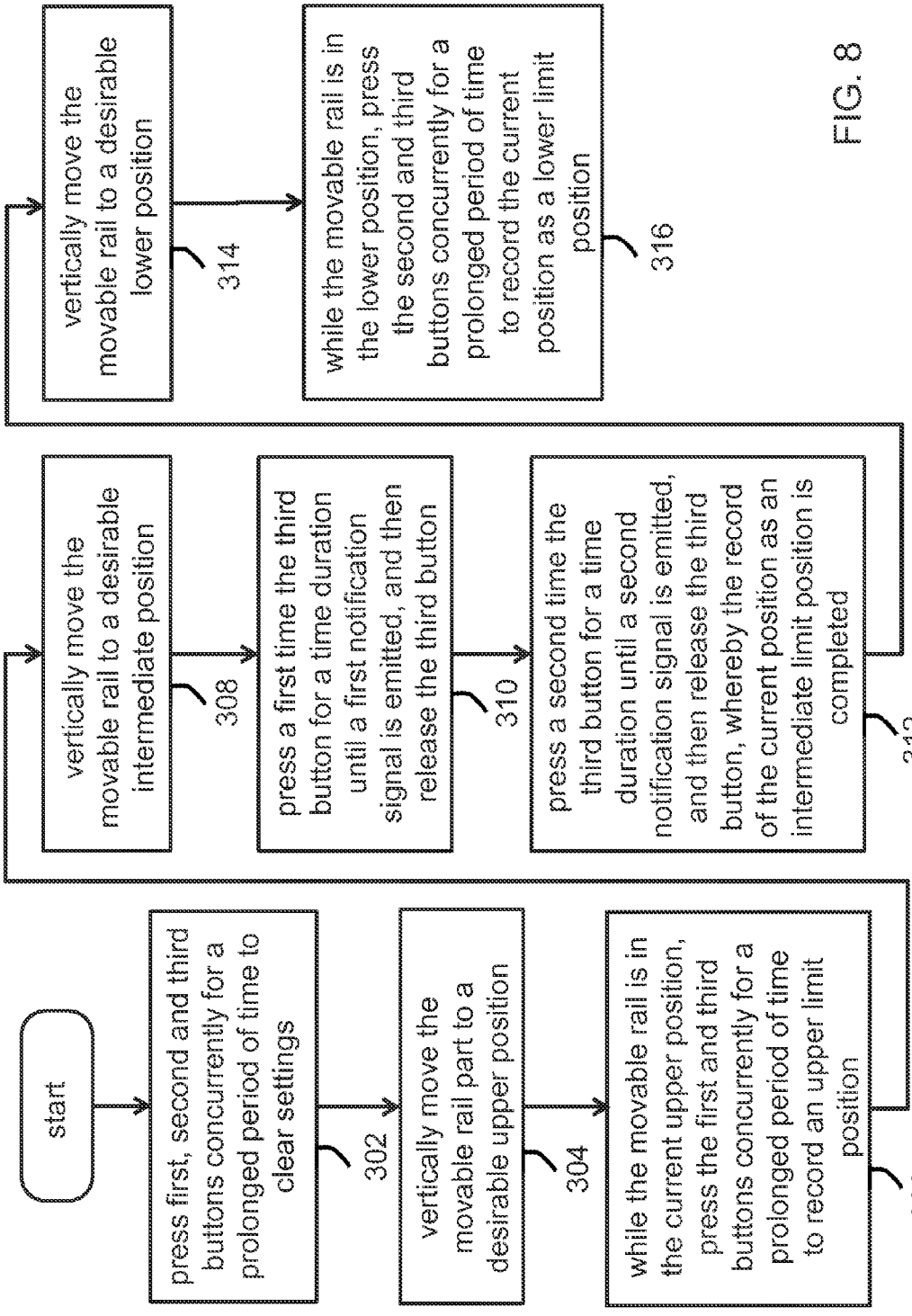

start
press first, second and third buttons concurrently for a prolonged period of time to clear settings
302
vertically move the movable rail part to a desirable upper position
304
while the movable rail is in the current upper position, press the first and third buttons concurrently for a prolonged period of time to record an upper limit position
306
vertically move the movable rail to a desirable intermediate position
308
press a first time the third button for a time duration until a first notification signal is emitted, and then release the third button
310
press a second time the third button for a time duration until a second notification signal is emitted, and then release the third button, whereby the record of the current position as an intermediate limit position is completed
312
vertically move the movable rail to a desirable lower position
314
while the movable rail is in the lower position, press the second and third buttons concurrently for a prolonged period of time to record the current position as a lower limit position
316

FIG. 8

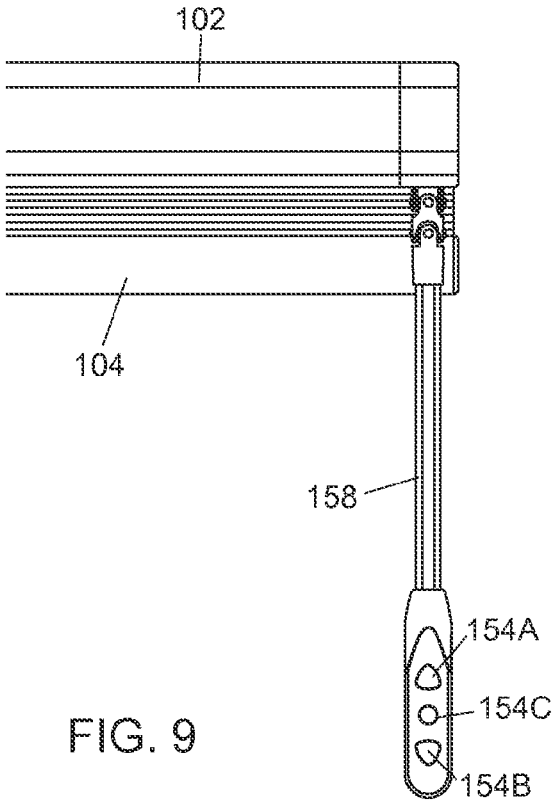


FIG. 9

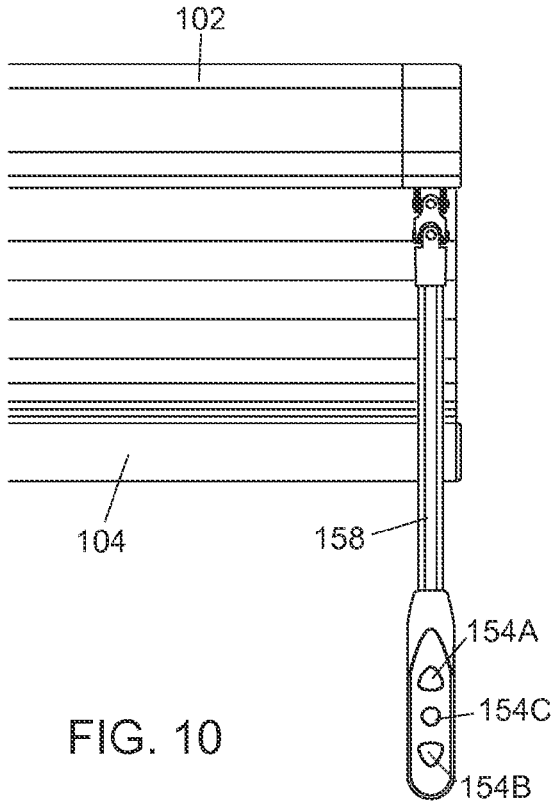


FIG. 10

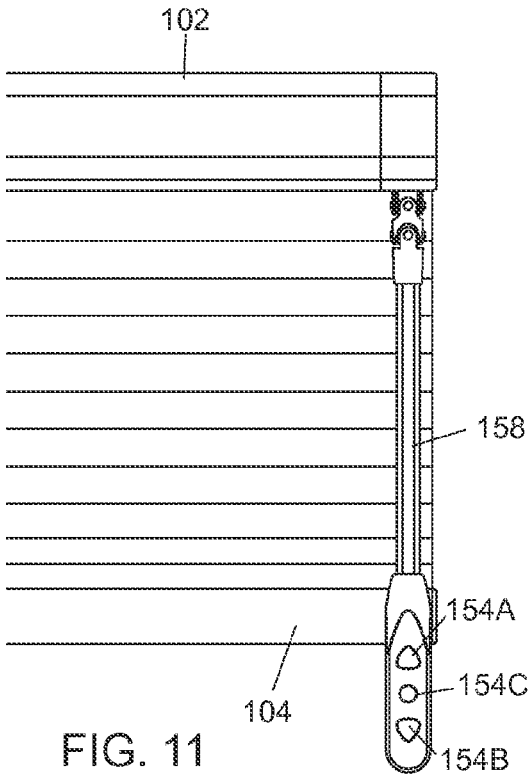


FIG. 11

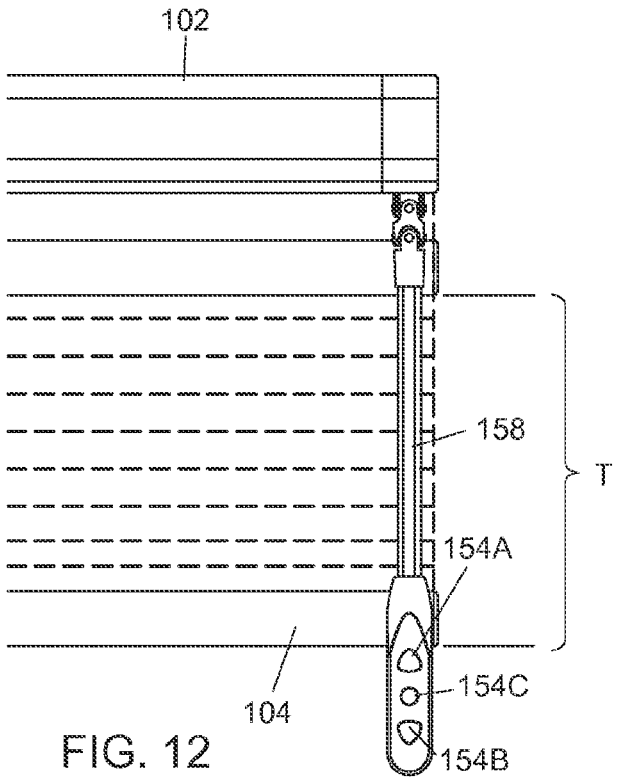


FIG. 12

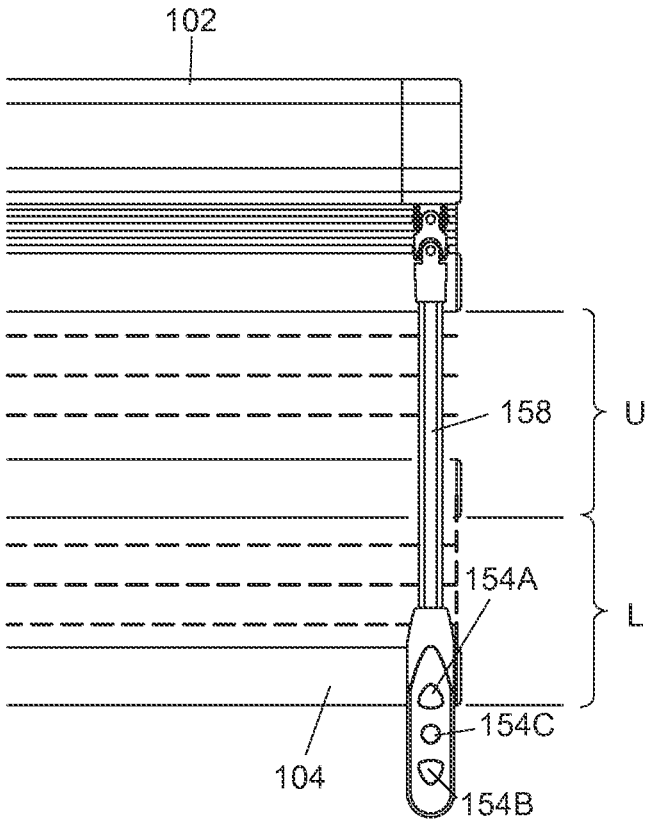


FIG. 13

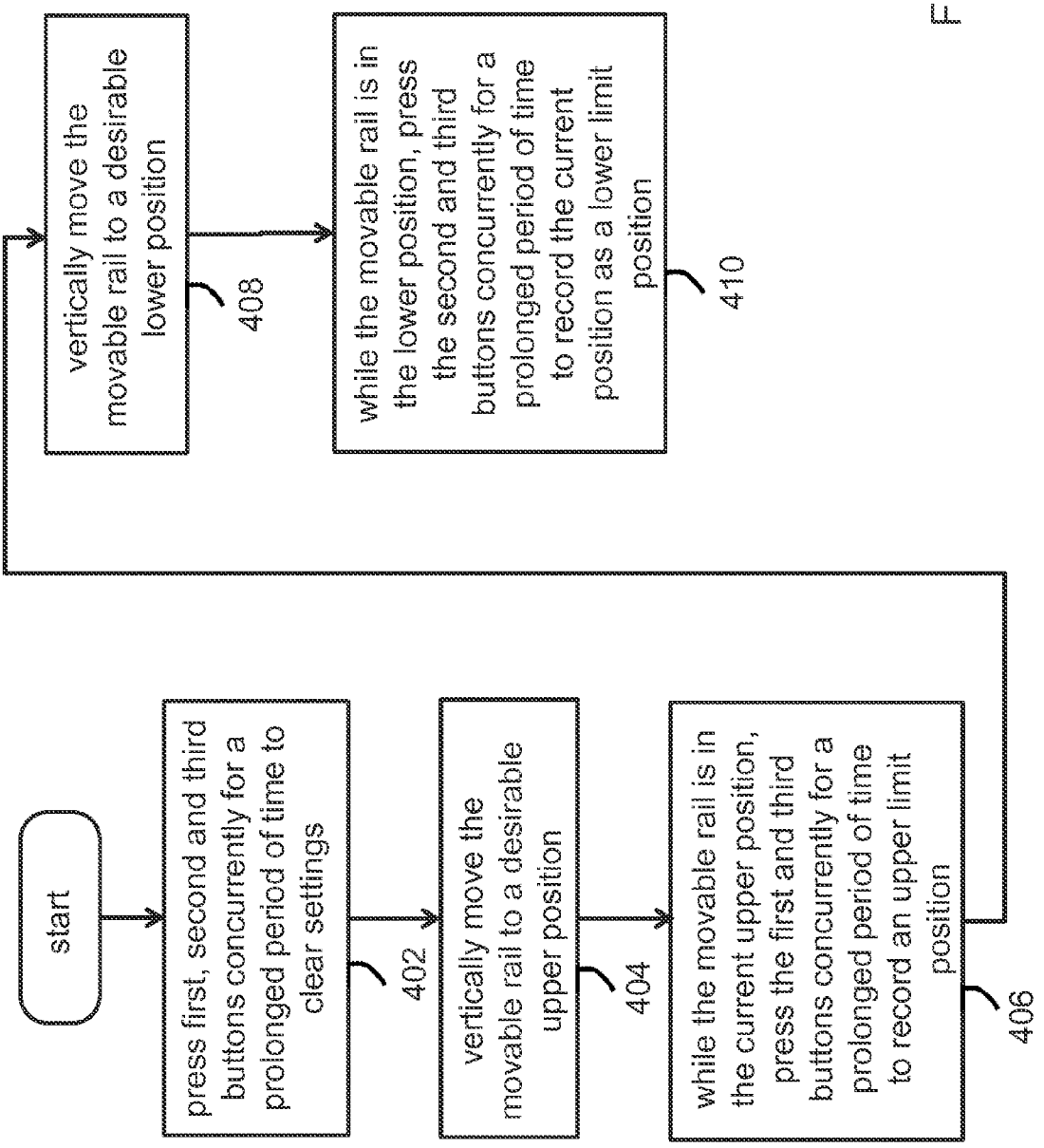

start
press first, second and third buttons concurrently for a prolonged period of time to clear settings
402
vertically move the movable rail to a desirable upper position
404
while the movable rail is in the current upper position, press the first and third buttons concurrently for a prolonged period of time to record an upper limit position
406
vertically move the movable rail to a desirable lower position
408
while the movable rail is in the lower position, press the second and third buttons concurrently for a prolonged period of time to record the current position as a lower limit position
410

FIG. 14

MOTORIZED WINDOW SHADE AND METHOD OF OPERATING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application respectively claims priority to U.S. Provisional Patent Application No. 61/923,275 filed on Jan. 3, 2014, and to U.S. Provisional Patent Application No. 61/938,782 filed on Feb. 12, 2014, both of which are incorporated herein by reference.

BACKGROUND

1. Field of the Invention

The present invention relate to motorized window shades and methods of operating the motorized window shades.

2. Description of the Related Art

Certain window shades may be provided with a motor that allows to conveniently raise and lower the shade. The motor and its power source may be disposed in a support structure mounted at a top of a window frame, and a remote controller may be provided to wirelessly control the operation of the motor. This type of motorized window shades is suitable for relatively higher end products, but not for lower end products owing to a higher manufacture cost. Moreover, while current motorized window shades may be able to set the upper and lower limit positions of the shade, the settings of the limit positions usually require multiple complex operating steps which may not be easily understood by a user.

Therefore, there is a need for a motorized window shade that is convenient to operate, economical to fabricate, and address at least the foregoing issues.

SUMMARY

The present application describes a motorized window shade that is easy to operate for setting limit positions. In one embodiment, the motorized window shade includes a fixed rail, a movable rail, and a covering structure arranged between the fixed rail and the movable rail. The window shade also includes an electric motor operable to drive displacement of the movable rail relative to the fixed rail, a control interface operable to control operation of the electric motor, and a motor controller respectively connected with the electric motor and the control interface. The control interface includes a first, a second and a third button, the first button being operable to cause displacement of the movable rail in a first direction, and the second button being operable to cause displacement of the movable rail in a second direction opposite to the first direction. The motor controller is configured to record a current position of the movable rail as a limit position of the movable rail in response to a pressure concurrently applied on the third button and one of the first and second buttons.

In another embodiment, a method of operating a window shade is described. The method includes providing a window shade including a fixed rail, a movable rail, a covering structure arranged between the fixed and movable rails, an electric motor operable to drive a displacement of the movable rail, a motor controller, and a control interface including a first, a second and a third button. Any of the first and second buttons is operated to cause displacement of the movable rail. While the movable rail remains in a current position, the method includes concurrently pressing the third button and one of the first and second buttons to record the current position as a limit position of the movable rail.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating an embodiment of a motorized window shade;

FIG. **2** is a schematic view illustrating a motorized actuating mechanism of the window shade;

FIG. **3** is a schematic view illustrating the construction of a winding unit in the window shade;

FIG. **4** is a schematic front view illustrating the circuitry connecting a motor controller, an electric motor, a power supply and a control interface used in the window shade;

FIG. **5** is a schematic rear view illustrating the circuitry connecting the motor controller, the electric motor, the power supply and the control interface shown in FIG. **4**;

FIGS. **6** and **7** are schematic views illustrating another embodiment of an actuating mechanism used in the window shade in which the power supply is replaced with a transformer;

FIG. **8** is a flowchart of method steps for setting an upper, an intermediate and a lower limit position of the movable rail in the window shade;

FIG. **9** is a schematic view illustrating an example of an upper limit position of the movable rail of the window shade;

FIG. **10** is a schematic view illustrating an example of an intermediate limit position of the movable rail of the window shade;

FIG. **11** is a schematic view illustrating an example of a lower limit position of the movable rail of the window shade;

FIG. **12** is a schematic view illustrating a use of the window shade within a preset range between the upper and lower limit positions;

FIG. **13** is a schematic view illustrating a use of the window shade within a first preset range between the upper and intermediate limit positions, and a second preset range between the intermediate and lower limit positions; and

FIG. **14** is a flowchart of method steps for setting an upper and a lower limit position of the movable rail in the window shade.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIG. **1** is a perspective view illustrating one embodiment of a motorized window shade **100**. The window shade **100** can typically be a vertical shade. The window shade **100** can include a fixed rail **102**, a movable rail **104**, and a covering structure **106** disposed between the fixed rail **102** and the movable rail **104**. The fixed rail **102** can be a head rail that may be affixed at a top of a window frame. The movable rail **104** can be a bottom rail disposed at a bottom of the window shade **100**. The covering structure **106** can have an upper end arranged adjacent to the fixed rail **102**, and a lower end arranged adjacent to the movable rail **104**. The movable rail **104** may be formed as an elongated rail or a weight element. In one embodiment, the covering structure **106** can be a honeycomb structure made of a fabric material, and include a plurality of cells. The honeycomb structure can have upper and lower ends respectively affixed with the fixed rail **102** and the movable rail **104**. In other embodiments, the covering structure **106** may be formed by a plurality of slats suspended from the fixed rail **102**.

In conjunction with FIG. **1**, FIG. **2** is a schematic view illustrating a motorized actuating mechanism **108** of the window shade **100**. The window shade **100** can also include a

motorized actuating mechanism **108** operable to displace the movable rail **104** toward or away from the fixed rail **102** so as to collapse or expand the covering structure **106**, and a control interface **120** operatively connected with the actuating mechanism **108**. The actuating mechanism **108** can include a plurality of winding units **112**, suspension cords **114** respectively associated with the winding units **112**, a rotary axle **116**, an electric motor **118**, a motor controller **122** electrically coupled with the electric motor **118**, and a power supply **124** electrically connected with the motor controller **122**.

The winding units **112** can be assembled in the fixed rail **102** at spaced-apart positions, and can be assembled coaxially about the rotary axle **116**. FIG. **3** is a schematic view illustrating the construction of the winding unit **112**. The winding unit **112** can exemplary include a casing **112**A, and a drum **112**B pivotally assembled in the casing **112**A and assembled with the rotary axle **116**. The winding units **112** thereby can be rotationally coupled with the rotary axle **116**.

Each of the suspension cords **114** (as shown in FIG. **1**) can have an upper end connected with the drum **112**B of one corresponding winding unit **112**, and a lower end connected with the movable rail **104**. The movable rail **104** can be thereby suspended vertically below the fixed rail **102**. The suspension cords **114** can pass through holes formed in the covering structure **106**.

The rotary axle **116** can be assembled through the drum **112**B of each winding unit **112**, so that the drums **112**B of the winding units **112** and the rotary axle **116** can rotate in unison.

Referring to FIGS. **1** and **2**, the electric motor **118** can be assembled in the fixed rail **102** via a mount fixture. In one embodiment, the mount fixture can include two brackets **130** affixed in the fixed rail **102**. An outer casing of the electric motor **118** can fit with the brackets **130** to be fixedly held in the fixed rail **102**. The electric motor **118** can have an output rotationally coupled with the rotary axle **116**, and can drive rotation of the rotary axle **116** in two opposite directions for raising and lowering the movable rail **104** relative to the fixed rail **102**.

FIGS. **4** and **5** are schematic front and rear views illustrating the circuitry connecting the motor controller **122**, the electric motor **118**, the power supply **124** and the control interface **120**. The motor controller **122** can be arranged at a location spaced apart from the electric motor **118**, the power supply **124** and the control interface **120**. The motor controller **122** can include a circuit board **132** that is at least partially enclosed in a casing **133**. The motor controller **122** can receive electrical signals from the control interface **120**, control operation of the electric motor **118**, and respectively transfer electric power received from the power supply **124** to the electric motor **118** and the control interface **120**.

The circuit board **132** can include a plurality of connectors **134**, **136** and **138** for electrical connections between the circuit board **132** and the electric motor **118**, the power supply **124** and the control interface **120**, respectively. For example, a cable **140** electrically connected with the electric motor **118** can have an end connector **140**A that may connect with and disconnect from the connector **134** of the motor controller **122**. A cable **142** electrically connected with the power supply **124** can have an end connector **142**A that may connect with and disconnect from the connector **136** of the motor controller **122**. A cable **144** electrically connected with the control interface **120** can have an end connector **144**A that may connect with and disconnect from the connector **138** of the motor controller **122**.

The use of detachable electric connection with the motor controller **122** can provide a more flexible and modular design, which allows easy replacement or change of the electric motor **118**, power supply **124** and control interface **120**. For example, FIGS. **4** and **5** show an embodiment in which the power supply **124** is a battery case **150**, and FIGS. **6** and **7** show another embodiment in which the power supply **124** can be replaced with a transformer **152**. The transformer **152** can be connected with the cable **142**, and can plug and unplug on a wall AC outlet in a house.

The modular design also allows a more flexible placement of the motor controller **122**, the electric motor **118** and the power supply **124** in the fixed rail **102**. For example, the electric motor **118** and the power supply **124** can be disposed at two opposite sides in the fixed rail **102**, and the motor controller **122** can be arranged between the electric motor **118** and the power supply **124**. This arrangement may provide a better weight distribution in the fixed rail **102**. Moreover, the motor controller **122** may be arranged at other locations outside the head rail **102**. For example, another embodiment may assemble the motor controller **122** in a casing **156** of the control interface **120**.

Upon actuation of the control interface **120**, the motor controller **122** can issue various control signals to the electric motor **118** so as to control rotation of the electric motor **118** in either direction. Moreover, the motor controller **122** can be programmable to set multiple ranges of rotational displacement of the electric motor **118**, which can correspond to upper, intermediate and lower limit positions of the movable rail **104**. In addition, the motor controller **122** can further include other devices, such as a visual or audio alert device operable to emit light or a sound to notify a user of certain states of the window shade **100**.

Referring to FIGS. **1**, **2**, and **4**-**7**, the control interface **120** can include a circuit board **154** that is provided with at least three buttons **154**A, **154**B, **154**C and is housed in a casing **156**. The cable **144** can have a first terminal end electrically connected with the control interface **120**, and a second terminal end arranged in the fixed rail **102**. A segment **144**B of the cable **144** extending outside the fixed rail **102** can be routed through an elongated tube **158** that extends vertically downward from a lateral end portion of the fixed rail **102**. The elongated tube **158** can have a substantially linear shape that substantially encloses the segment **144**B of the cable **144** outside the fixed rail **102**. In one embodiment, the elongated tube **158** can be a hollow wand made of a plastic material and having a hollow interior through which is passed the cable **144**. The elongated tube **158** can have an end **158**A fixedly secured with the control interface **120** (e.g., affixed with the casing **156** of the control interface **120**), and another end **158**B connected with a pivotal joint **160** disposed outside the fixed rail **102**. The end **158**A of the elongated tube **158** can be secured with the casing **156**, for example, through a slot and rib engagement. Other possible methods for attaching the end **158**A of the elongated tube **158** with the casing **156** of the control interface **120** can include welding, gluing, and the like.

Referring to FIG. **1**, a lateral end of the fixed rail **102** may be affixed with an end cap **162**. The pivotal joint **160** may include a first joint part **160**A that is affixed with the end **158**B of the elongated tube **158**, and a second joint part **160**B that is affixed with the end cap **162** and is pivotally connected with the first joint part **160**A. The first and second joint parts **160**A and **160**B can have tubular shapes for passage of the cable **144**.

With the aforementioned construction, the control interface **120** can be suspended below the fixed rail **102** by the elongated tube **158**. The length of the elongated tube **158** can be less than the maximum expansion of the covering structure **106**, but sufficiently long so as to allow easy access to the

control interface **120** held at the lower end **158**A of the elongated tube **158**. Moreover, the elongated tube **158** and the control interface **120** can pivot in unison about the pivotal joint **160** relative to the fixed rail **102** for facilitating grasping and manipulation of the control interface **120**. Moreover, the elongated tube **158** can advantageously provide protection for the cable **144**, which can prevent undesirable damages of the cable **144** and the risk of its accidentally lacing around the neck of a young child.

Referring again to FIGS. **1**, **2**, **4**-**7**, the buttons **154**A, **154**B, **154**C can be operable to control the vertical displacement of the movable rail **104** in upward and downward directions relative to the fixed rail **102**. In one embodiment, pressing on the button **154**A can cause the electric motor **118** to rotate for raising the movable rail **104** toward the fixed rail **102**, and pressing on the button **154**B can cause the motor **118** to rotate for lowering the movable rail **104** away from the fixed rail **102**. The buttons **154**A and **154**B may be operated by applying a short pressure or a prolonged pressure. A continuous pressure on the button **154**A for a prolonged time (e.g., more than 3 seconds) may activate a rise latching state that causes the electric motor **118** to continuously rotate for raising the movable rail **104**, even after the button **154**A is released. Likewise, a continuous pressure of the button **154**B for a prolonged time (e.g., more than 3 seconds) may activate a descend latching state that causes the electric motor **118** to continuously rotate for lowering the movable rail **104**, even after the button **154**B is released. The rise or descend latching state may be deactivated by pressing on any of the buttons **154**A, **154**B and **154**C.

The button **154**C can also be operated to cause the movable rail **104** to move toward a preset intermediate limit position. For example, when the movable rail **104** is located below the preset intermediate limit position, pressing on the button **154**C can cause the movable rail **104** to rise until it reaches and stops at the preset intermediate limit position. When the movable rail **104** is located above the preset intermediate limit position, pressing on the button **154**C can cause the movable rail **104** to lower until it reaches and stops at the preset intermediate limit position.

The buttons **154**A, **154**B, **154**C are also used to perform certain settings of the motor controller **122**. In particular, the buttons **154**A, **154**B, **154**C can be used to program an upper, an intermediate and a lower limit position of the movable rail **104**.

FIG. **8** is a flowchart of method steps for setting an upper, an intermediate and a lower limit position of the movable rail **104**, and FIGS. **9**, **10** and **11** are schematic views respectively illustrating examples of the upper, intermediate and lower limit positions. In initial step **302**, the three buttons **154**A, **154**B, **154**C can be pressed concurrently in a continuous manner for a prolonged period of time (e.g., 3, 4, 5 seconds or longer) to reset and clear the current settings in the motor controller **122**. In particular, any record of limit positions of the movable rail **104** may be deleted. A notification signal (e.g., a sound or light) may be emitted to indicate that the clearance of settings in the motor controller **122** is completed. Once the settings have been reset, the user can start the procedure for setting the upper, intermediate and lower limit positions of the movable rail **104**.

In step **304**, any of the buttons **154**A and **154**B can be pressed to displace the movable rail **104** vertically until it reaches a desirable upper position. It is noted that the motor controller **122** and the electric motor **118** may have a safety mechanism that can automatically stop the electric motor **118** in case the movable rail **104** has reached a top end position adjacent to the fixed rail **102**. This may prevent excessive upward course of the movable rail **104** which may abruptly collide against the fixed rail **102**. Once the movable rail **104** reaches the desirable upper position (as exemplary shown in FIG. **9**), the buttons **154**A and **154**B can be released.

In next step **306**, while the movable rail **104** remains stationary in the current upper position, the two buttons **154**A and **154**C can be pressed concurrently in a continuous manner for a prolonged period of time, e.g., 3 seconds, 4 seconds or longer. In response to the pressure concurrently applied on the buttons **154**A and **154**C, the motor controller **122** proceeds to record the current position of the movable rail **104** as an upper limit position of the movable rail **104**. This record may be made by reading and saving position data of a rotor in the electric motor **118** associated with the current position of the movable rail **104**. The motor controller **122** may operate to emit a notification signal (e.g., a sound or light) for indicating that the setting of the upper limit position is completed.

The record of the upper limit position as described in aforementioned step **306** thus can be performed in a simple way by operating only the two buttons **154**A and **154**C, whereas the button **154**B is kept in a release state.

In step **308**, the user can use any of the buttons **154**A and **154**B to vertically displace the movable rail **104** until it reaches a desirable intermediate position below the upper limit position. Once the movable rail **104** reaches the desirable intermediate position (as exemplary shown in FIG. **10**), the buttons **154**A and **154**B can be released.

While the movable rail **104** remains stationary in the intermediate position, a first pressing action can be applied on the button **154**C in step **310** for a time duration, until a first notification signal (e.g., a sound or light) is emitted. The buttons **154**A and **154**B are kept in a release state while the button **154**C is pressed down. Upon emission of the first notification signal, the button **154**C can be released.

After the first release of the button **154**C, a second pressing action is applied again on the button **154**C in step **312** for a certain time duration, until a second notification signal (e.g., a sound or light) is emitted to indicate that the record of the current position as an intermediate limit position is completed. While the button **154**C is pressed down for the second time, the buttons **154**A and **154**B are likewise kept in the release state. Upon emission of the second notification signal, the button **154**C can be released, and the record of the intermediate limit position is completed. Therefore, a sequence of two pressing actions can be successively applied on the button **154**C to record the intermediate limit position. The record of the intermediate limit position can be performed in a simple way by only operating the button **154**C, whereas the buttons **154**A and **154**B are kept in a release state.

It is noted that if no second pressing action were applied on the button **154**C within a certain period of time after the first pressing action, the record procedure of the intermediate limit position is aborted. In this case, steps **310** and **312** have to be repeated to record the intermediate limit position.

In step **314**, the user can use the buttons **154**A and **154**B to vertically displace the movable rail **104** until it reaches a desirable lower position below the intermediate limit position. Once the movable rail **104** reaches the desirable lower position (as exemplary shown in FIG. **11**), the buttons **154**A and **154**B can be released.

In step **316**, while the movable rail **104** remains stationary in the current lower position, the two buttons **154**B and **154**C can be pressed concurrently in a continuous manner for a prolonged period of time, e.g., 3 seconds, 4 seconds or a longer time. In response to the pressure concurrently applied on the buttons **154**B and **154**C, the motor controller **122** records the current position of the movable rail **104** as a lower

limit position of the movable rail **104**. This record may be made by determining position data of a rotor in the electric motor **118** associated with the current lower position of the movable rail **104**. The motor controller **122** may emit a notification signal (e.g., a sound or light) for indicating that the setting of the lower limit position is completed.

The record of the lower limit position as described in aforementioned step **316** can be performed in a simple way by operating only the two buttons **154**B and **154**C, whereas the button **154**A is kept in a release state.

It will be understood that the aforementioned settings of the upper, intermediate and lower limit positions of the movable rail **104** may be performed in any order. The motor controller **122** can track the number of revolutions performed by the electric motor **118** in either direction, and respectively record the distance between the upper and lower limit position, the distance between the upper and intermediate limit position, and the distance between the lower and intermediate limit position. In case no operation is performed within a time interval (e.g., 6 seconds or longer) after the completion of the settings, the motor controller **122** can automatically switch to an idle mode for saving power.

Once the settings of the upper, intermediate and lower limit positions of the movable rail **104** are completed, the user can use any of the buttons **154**A, **154**B and **154**C to adjust the height of the movable rail **104**. By counting the revolutions of the electric motor **118**, the motor controller **122** can detect when the movable rail **104** reaches any of the preset limit positions, and automatically stop the electric motor **118** so that the movable rail **114** is prevented from moving beyond the preset ranges of displacement.

Referring to FIG. **12**, in case the user wants to use the window shade **100** within a preset range T between the upper and lower limit positions, the buttons **154**A and **154**B can be used to move the movable rail **104** vertically to any position between the upper and lower limit positions. For example, the button **154**A can be pressed to raise the movable rail **104**, and the button **154**B can be pressed to lower the movable rail **104**. Any of the buttons **154**A and **154**B may be pressed for a prolonged period of time so as to activate a latching state that causes the electric motor **118** to continuously rotate for either raising or lowering the movable rail **104**, even after release of the button. The vertical course of the movable rail **104**, when controlled by the operation of the buttons **154**A and **154**B, is only limited by the preset upper and lower limit positions and can travel past the preset intermediate limit position. When the window shade **100** is adjusted by using the buttons **154**A and **154**B, the movable rail **104** can automatically stop when it reaches the upper or lower limit position.

Referring to FIG. **13**, in case the user wants to use the window shade **100** within a preset range U between the upper and intermediate limit positions, the buttons **154**A and **154**C can be used to move the movable rail **104** vertically to any position between the upper and intermediate limit positions. For example, the button **154**A can be pressed to raise the movable rail **104**, and the button **154**C can be pressed to lower the movable rail **104** toward the intermediate limit position. Any of the buttons **154**A and **154**C may be pressed for a prolonged period of time so as to activate a latching state that causes the electric motor **118** to continuously rotate for either raising or lowering the movable rail **104**, even after release of the button. The vertical course of the movable rail **104**, when controlled by operating the buttons **154**A and **154**C, is limited by the preset upper and intermediate limit positions. In other words, when the window shade **100** is adjusted by using the buttons **154**A and **154**C, the movable rail **104** can automatically stop when it reaches the upper or intermediate limit position.

In case the user wants to use the window shade **100** within a preset range L between the intermediate and lower limit positions, the buttons **154**B and **154**C can be used to move the movable rail **104** vertically to any position between the lower and intermediate limit positions. For example, the button **154**C can be pressed to raise the movable rail **104** toward the intermediate limit position, and the button **154**B can be pressed to lower the movable rail **104** toward the lower limit position. Any of the buttons **154**B and **154**C may be pressed for a prolonged period of time so as to activate a latching state that causes the electric motor **118** to continuously rotate for either lowering or raising the movable rail **104**, even after release of the button. The vertical course of the movable rail **104**, when controlled by operating the buttons **154**B and **154**C, is limited by the preset intermediate and lower limit positions. In other words, when the window shade **100** is adjusted by using the buttons **154**B and **154**C, the movable rail **104** can automatically stop when it reaches the intermediate or lower limit position.

If the user wants to clear all the settings, the three buttons **154**A, **154**B, **154**C can be pressed concurrently in a continuous manner for a prolonged period of time, e.g., 4, 5 seconds or longer. New settings of the upper, intermediate and lower limit positions of the movable rail **104** then can be performed as described previously. It is noted that the settings can be kept in the motor controller **122** even when power supply disruption occurs, e.g., during battery replacement. When no settings are made, the buttons **154**A and **154**B can be operated to raise and lower the movable rail **104** to any positions.

In some embodiments, the motor controller **122** may further be configured to enter a power saving mode when none of the buttons **154**A, **154**B, **154**C are operated for more than a preset time interval, e.g., for 6 seconds or longer. This may allow to reduce power consumption of the circuit board **132**.

It will be appreciated that the setting of limit positions as described above may be implemented in different embodiments of window shades. FIG. **14** is a flowchart of method steps for setting an upper and a lower limit position of the movable rail **104** in an embodiment of a window shade having no setting of intermediate limit position. Like previously described, the three buttons **154**A, **154**B, **154**C in initial step **402** can be pressed concurrently in a continuous manner for a prolonged period of time (e.g., 4, 5 seconds or longer) to reset and clear the settings of limit positions of the movable rail **104** in the motor controller **122**. A notification signal (e.g., a sound or light) may be emitted to indicate that the clearance of settings in the motor controller **122** is completed.

In step **404**, any of the buttons **154**A and **154**B can be pressed to displace the movable rail **104** vertically until it reaches a desirable upper position. Once the movable rail **104** reaches the desirable upper position, the buttons **154**A and **154**B can be released.

In next step **406**, while the movable rail **104** remains stationary in the current upper position, the two buttons **154**A and **154**C can be pressed concurrently in a continuous manner for a prolonged period of time, e.g., 3 seconds, 4 seconds or longer. In response to the pressure concurrently applied on the buttons **154**A and **154**C, the motor controller **122** proceeds to record the current position of the movable rail **104** as an upper limit position of the movable rail **104**. This record may be made by reading and saving position data in the electric motor **118** associated with the current position of the movable rail **104**. The motor controller **122** may operate to emit a notifi-

cation signal (e.g., a sound or light) for indicating that the setting of the upper limit position is completed.

In step **408**, the user can use the buttons **154**A and **154**B to vertically displace the movable rail **104** until it reaches a desirable lower position below the upper limit position. Once the movable rail **104** reaches the desirable lower position, the buttons **154**A and **154**B can be released.

In step **410**, while the movable rail **104** remains stationary in the current lower position, the two buttons **154**B and **154**C can be pressed concurrently in a continuous manner for a prolonged period of time, e.g., 3 seconds, 4 seconds or longer. In response to the pressure concurrently applied on the buttons **154**B and **154**C, the motor controller **122** records the current position of the movable rail **104** as a lower limit position of the movable rail **104**. This record may be made by reading position data in the electric motor **118** associated with the current lower position of the movable rail **104**. The motor controller **122** may emit a notification signal (e.g., a sound or light) indicating that the setting of the lower limit position is completed.

The record of the upper and lower limit positions as described in the aforementioned steps can be performed in a simple way by operating only two buttons at a time. Once the setting of the upper and lower limit positions are completed, the control interface **120** can be operated to displace the movable rail **104** within the preset range between the upper and lower limit positions.

It is worth noting that the aforementioned structures and methods are not limited to vertical window shades. In other embodiments, the features described herein may also be implemented in horizontal window shades in which the movable rail can move horizontally relative to the fixed rail to expand or collapse the covering structure.

The motorized window shades described herein include a motor controller that is coupled with a control interface having three buttons. The motor controller can record limit positions in a simple and easy way through operation of the three buttons of the control interface.

Realizations of the structures have been described only in the context of particular embodiments. These embodiments are meant to be illustrative and not limiting. Many variations, modifications, additions, and improvements are possible. Accordingly, plural instances may be provided for components described herein as a single instance. Structures and functionality presented as discrete components in the exemplary configurations may be implemented as a combined structure or component. These and other variations, modifications, additions, and improvements may fall within the scope of the claims that follow.

What is claimed is:

1. A window shade comprising:

a fixed rail, a movable rail, and a covering structure arranged between the fixed rail and the movable rail;

an electric motor operable to drive displacement of the movable rail relative to the fixed rail;

a control interface operable to control operation of the electric motor, the control interface including a first, a second and a third button, the first button being operable to cause displacement of the movable rail in a first direction, and the second button being operable to cause displacement of the movable rail in a second direction opposite to the first direction; and

a motor controller respectively connected with the electric motor and the control interface, wherein the motor controller is configured to:

record a first position of the movable rail as a first limit position of the movable rail in response to a pressure concurrently applied on the third button and the first button;

record a second position of the movable rail as an intermediate limit position of the movable rail in response to a sequence of a first and a second pressing action successively applied on the third button; and

record a third position of the movable rail as a second limit position of the movable rail in response to a pressure concurrently applied on the third button and the second button, the intermediate limit position being located between the first and second limit positions.

2. The window shade according to claim **1**, wherein the first button is operable to cause an upward displacement of the movable rail, the second button is operable to cause a downward displacement of the movable rail, and the first and second limit positions are respectively an upper limit position and a lower limit position beyond which displacement of the movable rail is prevented.

3. The window shade according to claim **1**, wherein the motor controller is further configured to emit a notification signal indicating that the record of the first or second limit position is completed.

4. The window shade according to claim **3**, wherein the notification signal is emitted when the third button and one of the first and second button are concurrently pressed over a period of time of 3 seconds or longer.

5. The window shade according to claim **1**, wherein the motor controller is configured to record the intermediate limit position after the record of the first limit position is completed.

6. The window shade according to claim **1**, wherein the motor controller is further configured to:

emit a first notification signal when the first pressing action has been applied on the third button for a predetermined first time duration; and

emit a second notification signal when the second pressing action has been applied on the third button for a predetermined second time duration.

7. The window shade according to claim **1**, wherein the third button is further operable to cause displacement of the movable rail toward the intermediate limit position, once the recording of the intermediate limit position is completed.

8. The window shade according to claim **7**, wherein the movable rail is movable vertically relative to the fixed rail, when the movable rail is located above the intermediate limit position, a pressure on the third button causes a downward displacement of the movable rail, and when the movable rail is located below the intermediate limit position, a pressure on the third button causes an upward displacement of the movable rail.

9. The window shade according to claim **1**, wherein the motor controller is further configured to clear any record of limit positions of the movable rail in response to a pressure concurrently applied on all of the first, second and third buttons.

10. The window shade according to claim **1**, wherein the motor controller is arranged at a location spaced apart from the electric motor, and is respectively connected with the electric motor and the control interface via electric cables.

11. The window shade according to claim **10**, further including a power supply spaced apart from the electric motor, power from the power supply being transmitted through the motor controller to the electric motor.

12. A method of operating a window shade, comprising:

providing a window shade including a fixed rail, a movable rail, a covering structure arranged between the fixed and movable rails, an electric motor operable to drive a displacement of the movable rail, a motor controller, and a control interface including a first, a second and a third button;

operating any of the first and second buttons to cause displacement of the movable rail, the first button being operable to cause displacement of the movable rail in a first direction, and the second button being operable to cause displacement of the movable rail in a second direction opposite to the first direction;

while the movable rail remains in a first position, concurrently pressing the third button and the first button to record the first position as a first limit position of the movable rail;

displacing the movable rail to a second position away from the first limit position, and successively applying a first and a second pressing action on the third button to record the second position as an intermediate limit position; and

displacing the movable rail to a third position, and concurrently pressing the third button and the second button to record the third position as a second limit position of the movable rail, the intermediate limit position being located between the first and second limit positions.

13. The method according to claim 12, wherein before the step of concurrently pressing the third button and the first button, the method further includes:

releasing the first and second buttons so that the movable rail remains stationary in the first position.

14. The method according to claim 12, wherein displacement of the movable rail in the first direction beyond the first limit position, and displacement of the movable rail in the second direction beyond the second limit position are prevented after the first and second limit positions are recorded.

15. The method according to claim 12, wherein either of the first and second limit position is recorded by concurrently pressing the third button and either of the first and second buttons over a period of time of 3 seconds or longer.

16. The method according to claim 12, further including:

concurrently pressing the first, second and third buttons to clear any record of limit positions of the movable rail.

17. The method according to claim 12, further including emitting a notification signal indicating that the record of the first or second limit position is completed.

18. The method according to claim 12, wherein the step of successively applying a first and a second pressing action on the third button to record the second position as an intermediate limit position includes:

applying the first pressing action on the third button until a first notification signal is emitted;

in response to the first notification signal, releasing the third button a first time and then applying the second pressing action on the third button until a second notification signal is emitted; and

in response to the second notification signal, releasing the third button a second time.

19. The method according to claim 12, wherein once the intermediate limit position is recorded, the method further includes:

while the movable rail is located between the first limit position and the intermediate limit position, pressing the third button to cause the movable rail to move in the second direction toward the intermediate limit position; and

while the movable rail is located between the intermediate limit position and the second limit position, pressing the third button to cause the movable rail to move in the first direction toward the intermediate limit position.

20. A window shade comprising:

a fixed rail, a movable rail, and a covering structure arranged between the fixed rail and the movable rail;

an electric motor operable to drive displacement of the movable rail relative to the fixed rail;

a control interface operable to control operation of the electric motor, the control interface including a first, a second and a third button, the first button being operable to cause displacement of the movable rail in a first direction, and the second button being operable to cause displacement of the movable rail in a second direction opposite to the first direction; and

a motor controller respectively connected with the electric motor and the control interface, wherein the motor controller is configured to:

record a first and a second limit position of the movable rail, the first limit position being recorded in response to actuation of the third button and the first button, and the second limit position being recorded in response to actuation of the third button and the second button;

record an intermediate limit position of the movable rail in response to actuation of the third button, the intermediate limit position being located between the first and second limit positions; and

control rotation of the electric motor for displacing the movable rail toward the intermediate limit position in response to a pressure applied on the third button.

21. The window shade according to claim 20, wherein the motor controller is configured to record the intermediate limit position of the movable rail in response to a sequence of a first and a second pressing action successively applied on the third button.

22. The window shade according to claim 20, wherein the third button is operable to cause displacement of the movable rail in the second direction toward the intermediate limit position when the movable rail is located between the first limit position and the intermediate limit position, and the third button is operable to cause displacement of the movable rail in the first direction toward the intermediate limit position when the movable rail is located between the intermediate limit position and the second limit position.

23. The window shade according to claim 20, wherein the motor controller is configured to record the first limit position in response to a pressure concurrently applied on the third button and the first button, and to record the second limit position in response to a pressure concurrently applied on the third button and the second button.

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